Request for Information

Non-destructive Evaluation of Large Heatshield Units Using X-ray Computed Tomography

Project: Heatshield for Extreme Entry Environment Technology (HEEET)

Preparation Date: 05/14/2015

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, California

1 Purpose & Scope

The Heatshield for Extreme Environments Technology (HEEET) project is planning to build three large (~1 m diameter) heatshield units for manufacturing demonstration and testing. These units must be screened using X-ray Computed Tomography (CT) technique to certify that they were made without flaws. The purpose of this Request For Information (RFI) is to provide background information, define the extent of this anticipated effort and gather information about the capabilities and relevant experience of potential CT vendors.

2 Background

The HEEET Project, co-funded by NASA's Space Technology Mission Directorate under the Game Changing Development Program (GCDP) and NASA's Science Mission Directorate (SMD) seeks to mature a game changing Woven Thermal Protection System (WTPS) technology to enable in-situ robotic science missions recommended by the NASA Research Council (NRC) Planetary Science Decadal Survey (PSDS) committee.

One of the primary deliverables for the HEEET project is an Engineering Test Unit (ETU). The ETU consists of a flight-like woven TPS heat shield that is assembled on a composite carrier structure. This integrated system will be put through a series of environmental tests. The ETU is a spherically-blunted cone with a base diameter of 1 meter and height of about 0.46 m. Since the TPS material cannot be manufactured in a single piece that is large enough to cover the entire surface of carrier structure, panels of TPS material will be assembled together to cover the entire area, thus requiring a seam to join panels together. These panels will be attached to the carrier structure using an adhesive material. A similar adhesive material will be used in the seams.

In order to certify that the ETU was built without unacceptable defects and that it survived the environmental tests without developing detrimental flaws, it is imperative to perform Non-Destructive Evaluation (NDE) of the seam region and the bondline (adhesive layer between TPS panels and carrier structure). The project has assessed multiple NDE techniques and has baselined the use of CT for screening the seam and bondline regions.

Prior to building the ETU, the project is planning to build an Integration Pathfinder Unit (IPU) and a Manufacturing Demonstration Unit (MDU) in order to practice and evaluate the integration and assembly approach. The MDU will be identical to the ETU except that it won't be tested. The IPU is approximately the same size and shape as ETU; however, the TPS panels are made of tooling foam instead of woven material and the carrier structure is an aluminum shell instead of composite solid laminate that is used in ETU and MDU. HEEET project is interested in scanning these three units. More details about each unit can be found in the next section.

3 Statement of Work

3.1 ETU

The ETU is a spherically-blunted cone with a half-cone angle of 45 degrees, base diameter of 1 meter, height of about 0.46 m and shoulder radius of 0.146 m. This system includes multiple components: a solid laminate composite carrier structure, TPS panels and seams that are assembled onto the carrier structure using an adhesive material. Figure 1 shows the layout of ETU TPS panels and seams. The panels include one nosecap, 6 inner tiles and 12 outer tiles.

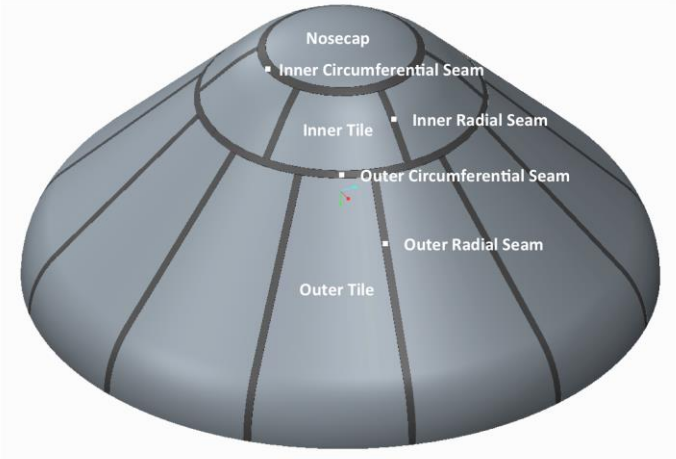

Figure 1. Layout of ETU TPS panels and seams

The carrier structure includes a metallic ring structure that is attached to the laminate skin using multiple metal fasteners. Figure 2 shows the carrier structure without TPS panels. Please note that the metallic ring cannot be detached during scanning.

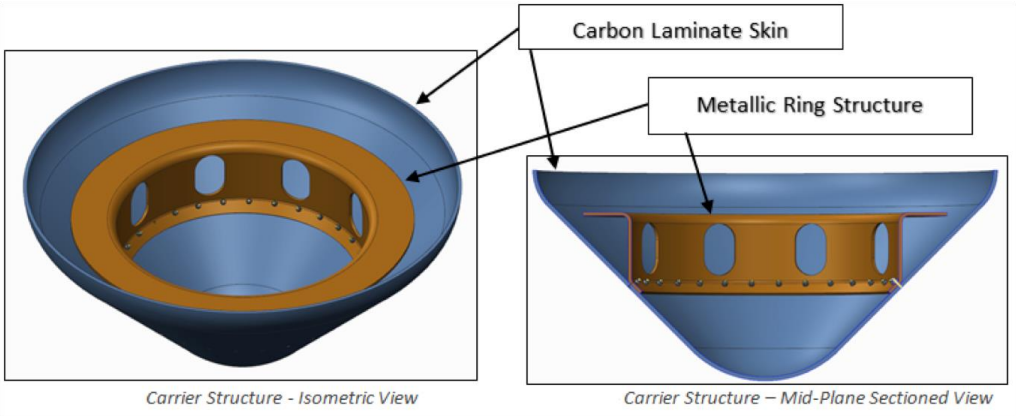

Figure 2. ETU carrier structure showing the metallic ring inside

The project is interested in scanning the bondline adhesive between the TPS and carrier structure and the seam regions between the panels. Since the unit cannot be dismantled after assembly, in order to scan these regions, a CT machine/apparatus that can house the

ETU will be needed. The unit does not have to be scanned as a single piece. A series of scans covering the regions of interest is acceptable. The ETU needs to be scanned once after it is built and once after the testing is complete. The ETU build is tentatively scheduled to be finished in August 2016. Testing is tentatively scheduled to be finished in July 2017.

3.2 MDU

The MDU will be exactly the same as ETU with the distinction that it won't be tested. Therefore, only one scan is required after it is built. MDU build is tentatively scheduled to be finished in April 2016.

3.3 IPU

The IPU is approximately the same size and shape as ETU, but the TPS panels are made of tooling foam instead of woven material and the carrier structure is an aluminum shell instead of composite solid laminate used in ETU and MDU. There is no metallic ring structure inside the aluminum shell. Instead, it is filled with low-density expanding foam. IPU manufacturing involves two phases. The first phase, already completed, involved the assembly of the nosecap and inner tiles. The second phase, scheduled to happen in Fall 2015, will involve the assembly of outer tiles. Upon the completion of the second phase, tentatively scheduled for September 2015, the project is interested in scanning the outer circumferential seams, the outer radial seams and the bondline between the aluminum shell and outer tiles.

4 Requested Information

Any organization responding to this RFI is urged to provide detailed answers to the following:

1. Provide information on the CT machine you are planning to use to complete these scans (size limitations, detector resolution, X-ray source power, etc.)
2. Describe the strategy you will use to scan the bondline and seam regions including an estimate of the total number of scans it will take to scan these regions.
3. Provide an estimate of image resolution (voxel size) you believe you can achieve for the regions of interest described in this RFI.
4. Provide an assessment of whether the metallic ring in the carrier structure will detrimentally affect scan quality and resolution. Are there ways to mitigate the impacts?
5. Provide a brief description of the holding fixture you will use to scan these units.
6. Describe what type of data may be delivered upon the completion of scans (such as. point cloud data, software to view data, videos)
7. Describe any additional data processing services that your organization may offer (such as efficient ways to extract CT data in the seam and bondline regions despite their complex geometry, scripts for auto-detection of defects of certain size and shape).
8. Provide an estimate of how long it takes to complete each of the required scans.
9. Will your organization need a smaller piece of material ahead of the larger units to guide technique development? If so, please describe the required material and the nature of development work that is anticipated.

10. Provide a summary of your organization's relevant experience with thermal protection materials and experience scanning articles of size similar to the units shown in this RFI.
11. While the immediate need is for scanning 1m-diameter heatshields, showing extensibility to larger heatshields (as large as 2.5 m in diameter) is of interest. What is the largest article your organization is capable of scanning?
12. Provide estimated cost for each of the scanning activities described in this RFI including the cost of scans, data preparation and fixture design.
13. For federal contracting purposes would you consider the described services to be of a commercial or non-commercial nature?
14. Does the North American Industry Classification System (NAICS) code of 541380, Testing Laboratories, with a SBA size standard of $15M see appropriate for a future procurement?
15. What is your company business size/ socioeconomic status for NAICS 541380?
16. If you are large, do you anticipate any subcontracting opportunities for this effort?